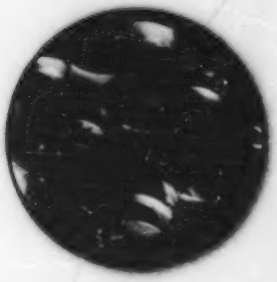
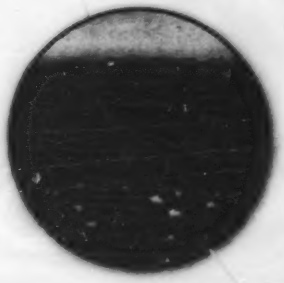
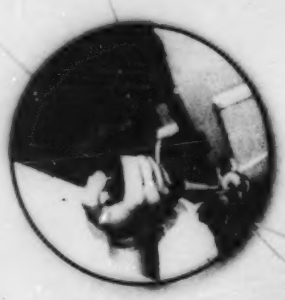






RESEARCH PROGRESS

LETHBRIDGE RESEARCH CENTRE

1998-1999 Annual Research Update

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

BOOSTING CANADA'S RESEARCH ENGINE: THE MATCHING INVESTMENT INITIATIVE

Dr. Brian Morrissey, Assistant Deputy Minister, Research Branch

The last few years have seen the emergence of a new power in agriculture: scientific research. With a range of benefits from advances in biotechnology to innovations in sustainable farming, research is an engine driving Canadian agriculture. It is determining how we compete on a global scale and, most importantly, how we maintain a successful industry throughout the next century.

Our progress will depend on partnerships. That's why like many of our colleagues in the research and agribusiness community, Agriculture and Agri-Food Canada (AAFC) is redefining how it works with public, business and industry. The goal is to maintain a healthy, efficient research sector while improving the transfer of research benefits to each of those parties.

A highlight of this effort is AAFC's Matching Investment Initiative (MII) Fund. The MII Fund was started in 1995 to encourage investment in agricultural research, strengthen ties with industry partners and leverage resources and expertise. Under MII, the federal government matches the investment of industry in qualifying research projects. The main criteria is that the research must both be part of our public mandate and confer an advantage to the industry partner. This means more funding for public research and an excellent investment opportunity for industry.

MII funds are high-mileage dollars. Because they leverage the core funding and resources already in place, they dramatically extend the research progress we get from our public budget. In addition, by working more closely with the private sector, we help ensure our research is responsive to industry needs. Closer ties to commercialization and marketing channels also allow us to get our technology into the hands of users more efficiently and successfully.

This year, the MII Fund is expected to allocate approximately $35 million across Canada, matching an equal contribution from industry. At the Lethbridge Research Centre alone, more than $3 million from MII is earmarked toward over 60 projects.

The bottom line is a dramatic infusion of new funding. That will boost our agricultural research engine and help it drive the progress of Canadian agriculture for many years to come.

102-06971/

A NEW ERA OF AGRICULTURAL RESEARCH

A NEW ERA OF AGRICULTURAL RESEARCH

Dr. Steve Morgan Jones, Director

As the century draws to a close, agriculture finds itself in a new era of arguably its most rapid change. The Lethbridge Research Centre is targeting its work to help Canadian agriculture meet the opportunities of this new era.

It's a time of new issues and challenges. Producers are facing increasing pressure to lower costs while delivering products with higher value. At the same time, society as a whole is recognizing the role of agriculture in the global economy, and is becoming more aware of the quality and safety of our food chain and of the sustainability of our environment.

This climate demands a broader, longer-term view of progress. Production improvements that increase profitability remain an important target, but how they are achieved is changing. In this new era, success will be measured not in short-term gains, but in long-term strategies that benefit the industry, meet the safety and quality needs of society and improve our management of the environment.

This approach is reflected in our research. For example, newer studies are addressing several controversial issues such as the impact of transgenic crops on the environment, the effects of antibiotic use in livestock production on drug resistance in humans, and the impact of feedlots on the environment. Others have important trade implications, such as studies to develop alternatives to the use of hormones in beef production systems.

These are only a few of many complex issues, often spanning commodities, industries and political boundaries. To address them, we believe an integrated research approach, backed by a broad range of resources is essential. With major sections in Livestock Sciences, Crop Sciences and Land Resource Sciences, the Lethbridge Research Centre has a unique collection of programs generating knowledge and technology. In addition, we work with a diverse group of partners, from the public to industry and private business. We are also active in the global research community, with a web of alliances and links to research resources worldwide.

Though our research is constantly evolving to meet new challenges, our scientific mandate remains the same: to support Canada's agri-food industry in the public interest. This Annual Research Update is an overview of the current research that is contributing to that goal. It highlights our people, our business and our programs.

Stephen Morgan Jones

OUR PEOPLE

The Lethbridge Research Centre now has more than 80 scientists in three core research sections and several related research sites. They are headed by the Centre Management Committee, comprised of management and section leaders. The Centre Management Committee determines direction, with advice from Agriculture and Agri-Food Canada leadership and the Centre's own Advisory Committee - a diverse group of third party public and industry representatives.

CENTRE MANAGEMENT COMMITTEE

Dr. Steve Morgan Jones
Director
Phone: (403) 317-2200
Email: morganjoness@em.agr.ca

Dr. Peter Burnett
Assistant Director
Phone: (403) 317-2202
Email: burnettp@em.agr.ca

Dr. Glenn Coulter
Assistant Director
Phone: (403) 317-2210
Email: coulter@em.agr.ca

Dr. Rick Butts
Head, Crop Sciences
Phone: (403) 317-2265
Email: butts@em.agr.ca

Dr. Walter Willms
Acting Head, Land Resource Sciences
Phone: (403) 317-2218
Email: willms@em.agr.ca

Dr. Bob Kemp
Acting Head, Livestock Sciences
Phone: (403) 317-2243
Email: bkemp@em.agr.ca

Marc Parent
Head, Administration
Phone: (403) 317-2204
Email: parent@em.agr.ca

1998/99 CENTRE ADVISORY COMMITTEE

Wayne Heller
Advisory Committee Chairman
Cow-calf rancher,
Heller Ranching Co. Ltd.
Medicine Hat, Alberta

David Andrews
Alberta Cattle Commission
Past President, Canadian
Cattlemen's Association
Beef producer
Bow City, Alberta

Clayton Campbell
British Columbia Cattlemen's
Association,
Rancher, James Creek Ranch
Merritt, British Columbia

Sylvia Campbell
President,
Southern Alberta Environmental
Group
Lethbridge, Alberta

Dr. Ralph Christian
Executive Director,
Alberta Agricultural Research
Institute
Edmonton, Alberta

Dr. Bob Christopherson
Associate Dean, Research
University of Alberta
Edmonton, Alberta

Peter Doris
Special Projects Manager,
Ontario Cattlemen's Association
Guelph, Ontario

Ray Grimson
Manager of Operations,
Lakeside Farm Industries Ltd.
Brooks, Alberta

Spencer Hilton
President,
Alberta Conservation Tillage
Society
Carbon, Alberta

Ian McGillivray
Potato producer,
Coaldale, Alberta

Larry McNamara
President and CEO,
Canbra Foods Ltd.
Lethbridge, Alberta

Lloyd Mercer
Seed grower,
Lethbridge, Alberta

Bryan Noble
Chairman,
Alberta Winter Wheat Producer's
Commission
Winter wheat producer
Nobleford, Alberta

Blair Roth
Manager,
Special Crops
Business Unit
Agricore
Lethbridge, Alberta

ex-officio
Dr. David Bailey
Director,
Lacombe Research Centre
Agriculture and Agri-Food Canada
Lacombe, Alberta

ex-officio
Dr. Bill Yates
Director,
Animal Diseases Research
Institute
Lethbridge, Alberta

OUR BUSINESS

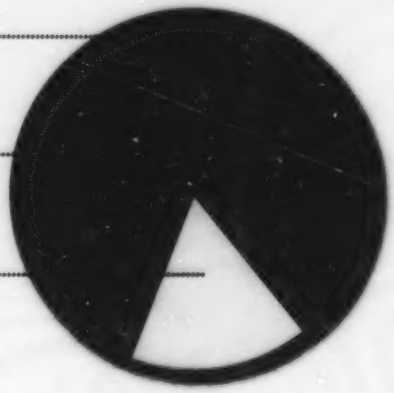
The Lethbridge Research Centre approaches science in a business-like manner to serve its public and private investors. A focus on sound strategic planning, innovation and creativity is reflected in the Centre's growing use of outside funding and new initiatives such as the creation of the Commercialization and Marketing Group.

OPERATING BUDGET 1998 - 1999

SALARY AND BENEFITS: $14.3 MILLION

OUTSIDE FUNDING: $10.4 MILLION

NON-PAY OPERATING: $4.9 MILLION



TOTAL BUDGET: $29.6MILLION

OUTSIDE FUNDING 1998 - 1999

CANADA/ALBERTA BEEF INDUSTRY DEVELOPMENT FUND: $1.3 MILLION

CANADA/ALBERTA LIVESTOCK RESEARCH TRUST: $900,000

AAFC MATCHING INVESTMENT INITIATIVE: $3.0 MILLION

INDUSTRY: $3.9 MILLION

OTHER RESEARCH FUNDING ORGANIZATIONS: $437,600

ALBERTA PROVINCIAL GOVERNMENT: $809,900

TOTAL OUTSIDE FUNDING: $10.4 MILLION

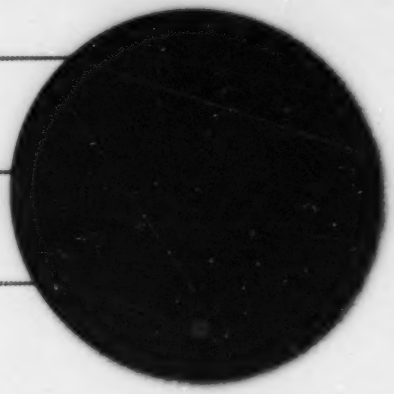
PROJECTED 1999 - 2000 OPERATING BUDGET

SALARY AND BENEFITS: $14.4 MILLION

OUTSIDE FUNDING: $10.4 MILLION

NON-PAY OPERATING: $5.1 MILLION

TOTAL PROJECTED OPERATING BUDGET: $29.9 MILLION



PROJECTED OUTSIDE FUNDING 1999 - 2000

CANADA/ALBERTA LIVESTOCK RESEARCH TRUST: $1 MILLION

INDUSTRY: $3.5 MILLION

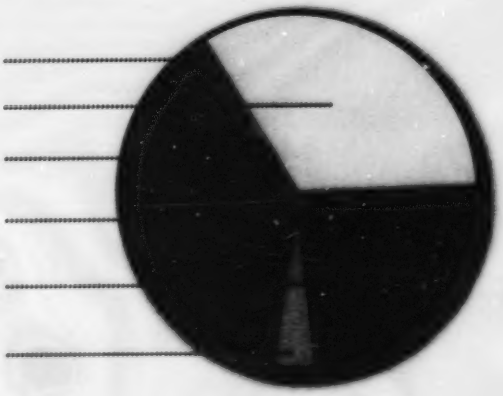
AAFC MATCHING INVESTMENT INITIATIVE: $3.1 MILLION

ALBERTA PROVINCIAL GOVERNMENT: $1.1 MILLION

CANADA/ALBERTA BEEF INDUSTRY DEVELOPMENT FUND: $1.4 MILLION

OTHER RESEARCH FUNDING ORGANIZATIONS: $439,600

TOTAL PROJECTED OUTSIDE FUNDING: $10.4 MILLION



Figures may change throughout year. Outside funding will increase as year progresses.

COMMERCIALIZATION AND MARKETING GROUP

The Centre has an in-house Commercialization and Marketing Group set up to manage business partnerships, transfer commercial technology, and protect intellectual property rights. The Group is designed to leverage the Centre's position as a producer of leading-edge agricultural research to benefit industry and the public.

CONTACTS

Dr. Glenn Coulter
Assistant Director
Phone: (403) 317-2210
Email: coulter@em.agr.ca

Ken Lievers
Commercialization Officer
Phone: (403) 317-2256
Email: lieversk@em.agr.ca

OUR RESEARCH

With major sections in Livestock Sciences, Crop Sciences and Land Resource Sciences, the Lethbridge Research Centre has a unique range of programs generating knowledge and technology.

An overview of activity follows in the "Research Highlights" section. For additional information on program activity or other aspects of the Lethbridge Research Centre, contact the Section directly, or contact the main Centre lines: phone (403) 327-4561, fax (403) 382-3156, email: lethbridge@em.agr.ca. The Centre's Web site, http://res.agr.ca/leth, will also be updated with specific study information.

The Lethbridge Research Centre welcomes questions, comments or suggestions at any time.

RESEARCH HIGHLIGHTS

Nutrition

Strategies for optimal performance, health, efficiency and product quality

Nutrition is a core factor in all aspects of livestock production. Scientists are developing nutritional strategies that improve the use of feed to both benefit the animal and improve production, while minimizing feed costs and environmental impacts.

Canola screenings as feed alternative. This research showed that canola screenings can reduce the cost of feedlot cattle diets by 16 percent when substituted for silage, depending on prices. However, levels of canola screenings in finishing diets should be no more than 50 percent of the total diet. To avoid fines and associated digestive problems such as bloat, handling of the pelleted screenings should be minimized and pellets should contain a binder to improve durability. This study showed that transition cattle should be adapted to canola screenings in a manner similar to how they are adapted to barley grain. Screenings could prove especially valuable when silage supplies are low.

Bunk management technology. Scientists validated a new system for continuously monitoring the feeding behavior of feedlot cattle. The system gives researchers access to precise information previously unavailable. An antenna in the feed bunk detects electronic ear tags on each animal, allowing a computer to record the time, location and duration of each bunk visit. Scientists can also closely monitor feed intake to determine the relationship between time at the bunk and actual intake. The system has been used to determine how different ionophores can alter the feeding patterns of feedlot cattle, and to evaluate the value of trainer cows for encouraging weaned calves to go on feed. Scientists are developing an even more advanced system that will continuously monitor the intake of individual animals housed in commercially-sized feedlot pens. The goal is to determine the point at which optimum feed intake results in minimal feed costs and maximum performance.

Yucca plant benefits. Preliminary results from this study showed that an extract from yucca plants can help control undesirable parasites and improve nitrogen metabolism in the rumen. The extract allows for better use of nitrogen by the animal. This means less nitrogen excretion and more nutrients available. Potentially, it can reduce protozoal numbers in the rumen, improve ruminal protein metabolism and improve the balance of rumen microbial populations. An industry partner will pursue the commercial use of the extract.

Feeding enzymes to cattle. The Lethbridge Research Centre continued to investigate the commercial potential of new technology to bring the benefits of feeding enzyme supplements to cattle. The patented technology, developed at the Centre over seven years of research and numerous livestock trials, is the most extensively researched enzyme application method to date. It has led to the development of feed enzyme products formulated specifically for cattle, giving producers a basis to ensure they apply enzymes at the most cost-effective levels to improve livestock performance. The patented application procedure has been verified in five dairy trials and nine feedlot trials under commercial conditions. Preliminary benefit:cost analysis showed about 2:1 benefit for beef cattle. This is in addition to other performance boosters such as ionophores and implants. For dairy cows, the benefit: cost was even greater at 4:1. The procedure works by establishing a complex between the enzyme mix and the feed before it enters the animal, ensuring stable feed-enzyme activity in the rumen.

Hulless barley benefits. Results were reported on a three-year project that assessed the nutritional value of hulless barley for ruminants. They showed that hulless barley allows producers to increase the digestible energy content of the diet. Its energy is similar to wheat and it has a higher protein content than covered barley.

Rumen-protected amino acids. New amino acid supplements that bypass the rumen may offer a more sustainable, low-cost alternative to commercial bypass protein supplements, studies showed. In basic dairy rations, only about 30 percent of feed protein reaches the small intestine for processing. Many dairy producers supplement feed with bypass protein products, also known as undegradable intake proteins, to get more protein through the rumen. However, the studies indicate that using rumen-protected amino acids can produce the same benefits with more efficiency. Rumen-protected amino acids are relatively new, and are expected to become widely available over the next few years. They contain regular amino acids, or their analogs, that have a unique ability to pass through the rumen intact. That characteristic is critical, because most unprotected amino acids degrade quickly in the rumen before reaching the small intestine where they can be absorbed.

Conjugated linoleic acids for consumer health. Scientists found that adding canola oil to goat diets increases the conjugated linoleic acid (CLA) content of its milk, resulting in healthier milk for consumers. CLAs are parts of linoleic acid that mitigate the effects of undesirable fatty acids, and have other health benefits. CLAs have been shown to stimulate the immune system, protect against heart disease and may have a role in preventing cancer. CLAs increase the level of healthier fatty acids and reduce those linked to cholesterol. Ongoing studies are investigating the potential of increasing the CLA content of beef and milk.

Rumen protozoa improve digestion. This study investigated the relatively unknown roles of various protozoa in the rumen as the first step toward a "protozoa recipe" to improve the efficiency of feed use. Research suggests protozoa have a significant effect on several aspects of rumen digestion. Controlling protozoa levels could improve everything from milk yield and quality, to secondary factors such as methane reduction. Protozoa are generally negative because they ingest valuable proteins before cattle can use them and their activity increases methane production. But for certain protozoa, those effects are low and are outweighed by the species' positive effects in both stabilizing rumen pH and helping prevent acidosis.

Barley grain processing. Processing is an important factor in getting more mileage out of barley grain, studies showed. The key is maintaining a balance between over-processing, which can lead to acidosis and metabolic diseases, and under-processing, which can reduce digestibility and performance. The studies also showed this balance differs for feedlot cattle and dairy cows. For high-grain feedlot finishing diets that are low in fiber, barley should be rolled to about 80 percent of its original density. In dairy cow diets, barley should be rolled to about 65 percent of its original density. In both cases, the extent of processing should be reduced if there is not enough effective fiber in the diet to minimize digestive upset.

Effective fiber. The effective fiber value of forages can be used to adjust the proportion of forage in cattle diets to compensate for differences in chop length, scientists determined. This is important because the key to getting more mileage from grain and forage in cattle diets is supplying an adequate amount of coarse fiber to maximize digestion and rumen function, and because the optimum amount of forage in cattle diets depends on particle length. Longer forage particles provide effective fiber, which promotes rumination. In a survey of barley silage from feedlots and dairies in Alberta, the effective fiber values averaged 63 percent, ranging from a low of 45 percent (fine) to a high of 85 percent (coarse). When harvesting barley silage, the silage must be chopped sufficiently fine to maximize fermentation within the silo. The key is to measure the particle length or effective fiber content after ensiling and adjust the rations accordingly.

Enzyme effects on cattle digestion. This study identified key enzymes that limit the rate of fiber digestion in the rumen, and looked at additional enzyme supplements with potential to boost performance. Ongoing test are evaluating various combinations.

Nutrient absorption. Scientists continued to develop strategies for maximizing nutrient absorption. Strategies are based on Centre data concerning the factors that affect nutrient absorption in the small intestine. The data show the influence of various intestinal parameters on the performance of various breeds of cattle.

Beef tenderness. In this study, the effects of nutritional modifications on carcass and meat quality were determined. The results will help develop neural network models to predict beef tenderness from carcass measurements.

Intercropped barley/ryegrass. The study showed that feeding silage from intercropped barley and annual ryegrass to growing or finishing steers - with minimum amounts of barley grain - meets nutritional requirements for optimal performance from the animal. The intercrop also yields over 50 percent more than barley for silage under the same growing conditions. In a series of experiments, steers performed significantly better on barley/annual ryegrass silage than on barley silage. Dry matter intake, average daily gain, feed conversion efficiency and carcass weights all improved for backgrounded steers. The strong showing makes barley/annual ryegrass silage a valuable alternative for efficient beef production in barley-based diets. The study also serves as a basis for determining the minimum amount of grain needed in the diet to produce an acceptable beef product.

Wagyu benefits. Scientists continued to study Wagyu cattle to learn why their digestion system is so effective at directing food energy for deposition of fat within muscle - the process that produces well-marbled meat. Researchers are examining the biochemical characteristics of the breed to develop tools for recognizing marbling potential in cattle.

Feed additives

New tools to expand production margins

The feed additives program is designed to tap the immense economic potential of feed efficiency gains.

Pathways to controlling AIP. Scientists identified 3-methylindole as a possible causative agent of Acute Interstitial Pneumonia (AIP) in feedlot cattle. Although others have proposed that Bovine Respiratory Syncytial Virus (BRSV) plays a role in the development of AIP, Centre researchers found no evidence of this virus in any of the animals they studied. It is becoming more apparent that AIP in Southern Alberta feedlots may arise from a complex interaction of feed intake, feed composition, individual animal physiology, and possible environmental triggers. With 3-methylindole, researchers now have a target to implement dietary or management practices that may provide cattle with a measure of protection from the disease. Part of the plan will be to explore the potential of management practices such as controlling dust, increasing the level of cysteine in the diet, and providing elevated levels of vitamin E as an antioxidant.

Bacteriocins as antibiotic alternative. Researchers continued investigating the potential of rumen-produced bacteriocins as natural antibiotic alternatives. Bacteriocins are natural protein antibiotics produced by bacteria in the rumen; current Lethbridge Research Centre scientists conducted the world's first systematic survey of rumen bacteriocins two years ago. Unlike current antibiotics widely used in the cattle industry, bacteriocins are not used in human medicine. This makes them a desirable alternative to prevent the development of disease-carrying bacteria that are resistant to antibiotics used by humans. Currently, producers tend to use a limited selection of antibiotic products over and over, increasing the risk of antibiotic resistance. The use of bacteriocins as alternatives to existing antibiotics would reduce that risk. The fact that bacteriocins are natural antibiotics originally isolated from the rumen of animals improves their chance of regulatory approval.

Improving enzyme performance. Cattle rumen contain natural enzymes that help break down feed and previous research showed that adding surfactants to the diet can enhance the activity of those enzymes. However, this study indicated that surfactants do not enhance the activity of enzymes that are added to the feed. In a related development, the surfactant did enhance the positive effect of the ionophore monensin on average daily gain during both backgrounding and finishing periods.

Delivering peptides and enzymes. Scientists continued working on yeast-based protection systems as a method of delivering biologically active proteins, such as enzymes and growth factors, to the small intestine of cattle. Traditional methods of protein protection such as heat or formaldehyde are effective, but they damage the structure that biologically active proteins rely on for their activity. Expressing genes for these proteins within the cell wall of the yeast *Pichia pastoris* protects them from degradation by rumen microorganisms. Preliminary experiments show that non-culturable cells remain intact in clarified ruminal fluid and water for over 24 hours. Ongoing studies are investigating live cells in ruminal fluid, and using specific growth and storage conditions (e.g., freeze drying) to increase the efficacy of this yeast system for post-rumen delivery.

Targeting rumen protozoa. This ongoing study established that cattle fed high-barley diets have sizable, diverse protozoa populations in the rumen. Since these microbes reduce the protein nutrition of cattle, scientists are testing a number of compounds - including saponin-containing plants, ionophores, fatty acids and surfactants - to limit rumen protozoa without affecting rumen bacteria, which would increase the efficiency of protein use in cattle.

Diversity of rumen bacteria. New molecular-based techniques revealed that the diversity of bacteria in the rumen is far greater than previously known. By comparing DNA sequences, scientists found several types that indicate a large number of new and potentially important bacterial groups remain to be discovered. They include groups of methane-producing bacteria and fibrolytic bacteria. Researchers have developed molecular probes for common rumen bacteria and are developing probes to identify and quantify the new groups.

Reducing phosphorus pollution. Experiments identified the major species of rumen bacteria involved in breaking down feed to release phosphorus and isolated a particularly vigorous strain. Phosphorus pollution from intensive livestock operations is increasingly seen as a significant problem; releasing more phosphorus in the rumen would allow livestock to use the nutrient rather than excrete it as waste. The bacteria degrade phytate, which is a major storage form of plant phosphorus. Since monogastrics, such as pigs, are particularly poor users of phosphorus, they are the first targets for application of this research. Improvements would also reduce the need for phosphorus supplementation.

Beef genetics and physiology

Boosting beef productivity

Improving Canada's cattle seedstock is the focus of a new, industry-driven approach to beef genetics research at the Centre. For decades, genetics research has focused on evaluation of different breeds and crossbreds in different environments, and that work is essentially completed. The new focus is on improving genetic strategies for specific traits that are economically important to the industry.

Carcass and meat quality. Researchers continued to evaluate ultrasound technology for predicting carcass and meat quality from measurements of breeding-age animals. Real time ultrasound technology works well on feedlot cattle just prior to slaughter, but scientists determined that the technology is also valid at the 12-14 month age range, when most producers are making their selection decisions. Correlations among carcass and ultrasound measures at 12 months of age and immediately before slaughter were found to be significant. The next step is to develop a long-term breeding selection project, using ultrasound measures, to improve overall carcass and meat quality.

Female reproductive efficiency. The use of real time ultrasound technology as a tool for predicting female reproductive efficiency was studied. Current techniques require a "wait and see" approach to determine the best breeders, but researchers found that it is best to use the tool for selection at 12 to 14 months, when most animals enter the breeding herd for the first time. As heifers go through puberty, follicles develop on their ovaries. Scientists plan to measure the number of these "follicular waves," since previous research indicates that heifers with three waves may be more fertile than those with only two. In addition, ultrasound infrared thermography of the testicles of related males will be used to examine relationships for predicting female fertility.

EPD development. Ongoing genetic improvement studies focused on developing Expected Progeny Difference (EPD) indicators of valuable traits and better data analysis tools. EPDs are the main tools for genetic evaluation, but are only the first step in the overall genetic improvement program. In related work, scientists are looking at better ways to use developments in statistical evaluation technology for analyzing more data faster and develop sophisticated genetic models. The ultimate goal is to improve the seedstock side of the cattle business and effectively transfer those genetics to the commercial side.

Livestock physiology

Enhancing reproduction, growth and feed efficiency and quantifying stress

Understanding reproductive, nutritional and growth processes to increase long-term animal efficiency is the focus of physiological research. Researchers are also working on objective measures of animal stress and pain by studying blood hormone levels and animal behaviour.

Stress indicators. One study found that beta-endorphin and cortisol profiles of sheep help indicate different types of stressors. Painful stressors cause the levels of both hormones to rise significantly for a prolonged period, while psychological stressors cause shorter-term cortisol and limited beta-endorphin responses. A related study indicated that the hormone profiles of ewes were not directly altered by shearing; this indicates that the primary stress during shearing is caused by moving, handling and restraint. The study also showed that previous exposure to shearing markedly increased the stress response to later handling and shearing.

Hormone effects on energy and growth. One study found that high levels of dietary corn or barley increased the viscosity of digesta in the duodenum. This caused an increase in insulin, which controls nutrient uptake and partitioning. Another study with Wagyu crossbred steers suggested a link between glucose use and marbling potential. The Wagyu steers showed a delayed insulin response to intravenous glucose challenges, in comparison to non-Wagyu steers.

Bull fertility. Researchers studied scrotal and testicular temperatures and used ultrasound and infrared thermography in this ongoing study to predict semen quality and fertility in breeding bulls. Approximately 100 breeding bulls have been examined at artificial insemination centres. Researchers will examine links betweem physical measurement, temperature, and ultrasound data, and changes in semen quality associated with environmental temperatures. They are also measuring blood flow and oxygen delivery to the testes, to better understand the effects of increased testicular temperature on semen quality.

Suppressing reproductive function. Reproductive function in feedlot cattle disturbs feed intake and growth and makes animals more difficult to manage. Scientists used a novel vaccine to successfully suppress reproduction in both heifers

and bulls. They also used an electronic mount detector to monitor feedlot heifers that were treated with methods of suppressing estrus, including both traditional (MGA in the feed) and novel (an intrauterine device) methods.

Synchronizing estrus and ovulation in cattle. Scientists built on their experience in synchronizing estrus in cattle by synchronizing ovulation, allowing for fixed-time insemination, with good fertility. These ongoing studies are being conducted on a large scale, under commercial conditions.

Bovine Epidermal Growth Factor. Researchers took a first step toward developing a new feed additive. They made significant progress toward identifying the gene segments responsible for producing Bovine Epidermal Growth Factor (EGF), an inexpensive feed additive that could enhance nutrient absorption and promote general intestinal health.

Livestock economics

Transforming research into profitability

Canada's continued success in high quality beef production depends not only on research and development, but on the ability to translate that technology into marketable economic benefits. Livestock economics studies examine the value of genetics and physiology strategies in beef production systems.

Economically-important traits. This ongoing study updated the economic potential of various genetic improvement strategies. Computer simulation was used to analyze new reproductive and performance-predicting technologies such as molecular marker assisted selection, ultrasound imaging and meat quality probes. The data will help develop procedures for economically-important beef production and product traits.

Estrus synchronization. This study found that recently developed estrus synchronization/artificial insemination (AI) regimes, which control corpus luteum and follical growth, returned $30-40 per cow exposed over natural service. By comparison, more classical AI regimes are only marginally profitable. Estrus synchronization is profitable only if the costs of synchronization and AI are offset by improved revenues from increased weaning rates (from a reduction in the length of the calving season), more calves produced and fewer bulls required.

Bull virility. This project continued to determine the correlation between scrotal/testicular temperature and breeding soundness/libido. In the first study phase, researchers determined the susceptibility to heat of seminal quality and production. The data will be used to develop models for predicting bull breeding quality.

New early life selection study. Researchers began this work to develop early-life selection criteria for female reproductive efficiency using ultrasound technology. The results will lead to models for further genetic improvement strategies.

Immunization protocols. A preliminary study was conducted to extract adipose membrane from slaughtered cattle for use as a vaccine. It's part of an ongoing effort to determine the effects of various active immunization protocols on cattle performance.

Nutrient absorption. Preliminary preparations were made for this study to evaluate the impact of dietary components on the transit time of digesta and on the potential for nutrient absorption. Diets of varying proportions of rolled barley or rolled corn will be fed to cattle and samples will be taken from strategic locations in the duodenum and portal vein to determine the impact.

Hormone, blood effects. In one study, the relationship between circulating adrenal and thyroid hormones and calf growth rate were determined to analyze the economic benefits of treatment. In a new study with lambs and calves, research was begun to determine the relationship between plasma somatomedin and rates of growth and nutrient partitioning.

Effects of stress on ruminants. Working with sheep and cattle, researchers continued to determine the effects of stress on ruminant performance. The plan is to find ways to measure stress and use the information to develop stress-reduction strategies. Since stress has been linked to reduced performance, those strategies would have a significant economic impact.

Livestock pests

Moving toward sustainable controls

Thinking strategically is the key to pest control in modern feedlots, a concept that is reflected in the Centre's integrated approach to livestock pest management. Scientists are targeting strategies to help the beef industry adapt to new challenges by integrating long-term control alternatives that are economically and environmentally sustainable.

International Livestock Insect Worker's Conference hosted. Lethbridge Research Centre scientists organized the 1998 Livestock Insect Worker's Conference. This meeting brought together livestock insect researchers from Europe, Australia, and North America to discuss new ideas and approaches to livestock pest management. About 110 delegates attended the conference and 43 papers were submitted. The delegates represented government, universities and private industry. The conference is in its 42nd year.

Horn fly diapause. Horn fly larvae must enter a state of arrested development called diapause in order to successfully overwinter and persist in colder climates. Researchers identified the active DNA of diapausing pupae and are further studying its role to find ways of controlling diapause. They also initiated a collaborative research program with the USDA Kerrville, Texas, laboratory to examine gene regulation in diapausing horn flies.

Fly-microbe interactions. Scientists determined the effect of selected bacteria on stable fly larvae. Results showed that several species of bacteria are potential microbial controls of stable fly larvae, while others are used by the larvae for growth and development. The results will contribute to the development of bioassay procedures for evaluating the toxicity of bacteria used in microbial control programs against the stable fly.

Microbial control of flies. Three novel subspecies of *Bacillus thuringiensis* have shown enhanced activity against horn fly larvae, compared with standard Diptera-specific strains, researchers found. Further study will examine the effect of these strains against stable fly larvae and determine the toxic components responsible for mortality.

Population modelling. Experiments allowed researchers to separate post-diapause development from diapause development in population models. They also developed a model for simulating the spring emergence of horn flies. Results assist with simulation of management strategies for this pest.

Tick paralysis. Ongoing studies focused on identifying the toxin associated with tick paralysis.

Cattle grub control. An ongoing study evaluated recombinant antigens as components for a vaccine to protect cattle against cattle grubs. Variable results so far indicate that the structure of the recombinant protein is important in developing protective immunity.

Lice control. In collaboration with a large animal health corporation, researchers described the comparative efficacy of eight treatment protocols for managing lice. They also evaluated the persistent activity of five endectocides against controlled lice infestations.

Stress from biting flies. Scientists continued this study on how biting flies affect cattle stress. Using a model, they described the induction of conditioned analgesia caused by a stable fly attack and the neurochemical basis of sex differences. Researchers also measured changes in host behaviour induced by parasitism, which suggest coordinated management approaches are important for controlling pests and parasites.

Biocontrol of stable flies. Researchers evaluated the parasitic wasp *Muscidifurax raptorellus* as a biological control agent. This wasp is sold commercially for controlling the stable fly and house fly. Parasitic wasps search out fly pupae and deposit eggs that produce larvae capable of killing flies as they develop inside the pupae. Results from the two-year study showed that this non-native species can travel as far as 100 m from the point of release to seek fly pupae, but has a very low overwintering survival rate. Therefore, fly control using this wasp depends on several releases each year. Parasitic wasps are very small (less than 2 mm), feed only on a select group of flies and are not harmful to people, plants, or animals.

New wasp for biocontrol. A province-wide feedlot survey revealed that the wasp *Trichomalopsis sarcophagae* is relatively abundant in Alberta, and has potential as a biological control agent. The wasp lays its eggs in the pupae of stable and house flies. The species can be readily mass-reared for release in feedlots and because it is native, successfully overwinters in Alberta. Experiments showed that the wasp will seek fly pupae as far as 100 m from the point of release and that mass-release in feedlots produced large, short-term improvements in fly control. Researchers will repeat these studies to provide more information on commercialization potential.

Endectocide effects on insects. Researchers initiated studies to follow up on previous research showing that the use of the product ivermectin can reduce insect activity in the dung of treated cattle, which can in turn reduce the natural

rate of dung degradation. The new research asks whether this is also true for three other endectocidal products on the market: doramectin, eprinomectin, and moxidectin. Results will provide cattle producers with the information to select the most appropriate product for their needs.

Forage

Fundamentals for growth

The western forage industry is in a growth phase, thanks to an expanding cattle industry across the west, a new prominence of forages as cash crops with value-added potential, and growing recognition of forages' agronomic benefits. The forage program is pursuing strategies to help meet the evolving research needs of that industry.

Bloat-safe grazing of alfalfa. Research at Agriculture and Agri-Food Canada centres in Lethbridge, Kamloops, Lacombe, and Saskatoon continued work towards a bloat-safe grazing system for alfalfa. Previously, researchers announced the release of AC Grazeland, which will be an important part of the "tool box" of technologies that will lead to bloat-safe alfalfa grazing. Researchers are now looking at mixed pastures of AC Grazeland and sainfoin (a legume known to be bloat-safe), to provide additional bloat protection for cattle, without reducing the productivity of legume pastures. Further work will examine the use of pluronic detergents to prevent bloating. Results from experiments at Kamloops, Lethbridge, and Lacombe showed that one of these compounds was 100 percent effective in preventing bloat in cattle grazing on alfalfa pastures; researchers are pursuing registration in Canada.

Alfalfa varieties. Alfalfa variety LRS 93-1 was approved for registration. It adds to previously registered varieties Barrier and AC Blue J - all part of the forage program's disease control effort. All three cultivars are resistant to bacterial wilt and verticillium wilt, the main disease threats for alfalfa in irrigated areas of Western Canada. The varieties yield well under irrigation and are long-lived because of their superior adaptation characteristics and disease resistance. AC Blue J and LRS 93-1 also perform well on dryland. Scientists are working on strategies to reduce bloat in these disease resistant cultivars.

Alfalfa as sustainability tool. Scientists continued this project to measure the water uptake potential of various types of alfalfa. The plan is to identify alfalfa material that can serve a purification role in farming by protecting groundwater quality. Because alfalfa uses high levels of water, it has potential to draw down the water table - that can help prevent leaching of chemicals, reduce salinity and restrict the movement of feedlot wastes containing nitrates and urea.

Perennial cereal rye. Research continued on perennial cereal rye, which shows many advantages over barley as a silage crop. This forage matures a few weeks earlier than barley, but has almost identical yields and nutritional quality. The crop persists for several years, takes advantage of spring moisture and has good regrowth for a second cut of hay or pasture. But the crop has some hurdles to cross. Because it is a hybrid of two distinct species, it produces many sterile flowers. Its extended flowering period makes the crop vulnerable to seed-borne diseases such as ergot. Scientists are working to reduce the sterility level and develop strategies for maximizing forage and seed yield.

Fenugreek. Scientists discovered that this crop, new to Canada, has exciting potential as an alfalfa alternative. The high-protein legume grown in India and other countries makes good silage and is a natural source of valuable steroids that may increase muscle development. Like alfalfa, it's a high-quality legume that fixes nitrogen in the soil. But while alfalfa is a perennial, fenugreek is an annual crop. It has slightly less dry matter and protein, but is relatively equal in terms of nutritional quality for cattle and holds its quality after blooming, giving producers more flexibility for harvest. Preliminary experiments also suggested fenugreek may be bloat-safe.

Superior cicer milkvetch variety. Scientists dramatically improved yield potential for cicer milkvetch with a new variety that makes the crop arguably an ideal pasture legume. Preliminary trials showed yield twice that of Oxley, the current standard variety. Cicer milkvetch has been a neglected legume with good potential, especially for grazing, and scientists are now reaching the crop's potential. The new variety was bred specifically to eliminate seedling vigor problems. Results showed it is long-lived, nonbloating, grows well, has no serious diseases or insect pests; as well, pocket gophers leave it alone and cattle readily graze it. The legume yields five to six tons of dry matter per acre under irrigation, about the same as alfalfa in a two-cut system, but less than alfalfa in a three-cut system.

Agronomy initiative. With alfalfa disease resistance goals achieved, researchers continued a new focus to develop cultivars and strategies that produce high yields over many years under difficult conditions. The goal is to develop stands and management techniques so alfalfa can compete well with grasses and perform better on acid soils and areas of long-term grazing. Most commercially-available alfalfa varieties were developed in pure stands and were not selected for their ability to compete with grasses. Researchers worked at ways to manage

mixed stands so that grasses do not overwhelm the alfalfa. They searched for alfalfa genetic material adapted to the competitive environment of a mixed forage stand, and for other materials for the program's new direction, such as plants from very old stands on acid soil, stands that competed well with grasses, as well as stands that have withstood long-term grazing.

Blossom blight disease. A study on the blossom blight pathogen showed how the disease infects plants and its effect on pod development, seed yield and seed quality. The results will lead toward control measures against this disease.

Weed management for new forages. Field experiments continued to assess herbicide and management techniques for controlling weeds in fenugreek and perennial rye. Initial results showed fenugreek yield increased up to 79 percent with appropriate herbicides. Perennial rye showed good competitiveness with weeds and seemed to tolerate all of the herbicides registered for fall rye.

Intercropping annual barley, annual ryegrass and annual legumes. A study at the Kamloops, B.C., Range Research Ranch showed that intercropping annual legumes with annual barley and annual ryegrass can improve forage yield and quality.

British Columbia agronomy. Several studies were part of an ongoing effort to develop improved cultural practices for sustainable forage production in interior British Columbia.

Manure management

Reducing waste, boosting nutrient value

The rapid intensification of livestock production on the prairies has been accompanied by a growing need to address the issue of animal wastes. Livestock manure is very beneficial to crops when applied at appropriate rates, but many of today's intensive livestock operations simply don't have enough land nearby to dispense manure properly. Scientists are pursuing ways to not only manage that resource, but to take advantage of its nutrient value.

Long-term studies. The Centre's long-term manure plots established in 1973 continue to provide valuable data for the sustainable use of manure in cropping systems. Researchers continued to monitor the plots to determine changes in soils as affected by various application rates of fresh manure.

Reducing volatilization losses. Scientists continued to study nitrous oxide emissions from soil treated with various high rates of feedlot cattle manure, to determine correlations between volatilization rates and environmental factors such as temperature and soil moisture. The study is part an effort to develop methods to control nitrogen losses from manure during storage, and to explore composting and land application methods that conserve nutrients and reduce environmental impact.

Impact of manure phosphorus. Manure is generally applied at rates to meet the nitrogen requirements of crops, but researchers have recognized the potential benefits of phosphorus-based applications. Nitrogen-based strategies leave potential for a buildup of phosphorus at the soil surface, which is capable of contaminating surface water by runoff. To reduce the effects of "P-loading," researchers continued to evaluate the environmental impact of this input. In the initial phase, laboratory experiments are assessing potential salinity and P-loading problems after repeated applications of fresh feedlot manure.

Rebuilding eroded soils. Researchers assessed the potential of manure to restore the productivity of artificially eroded soils and decommissioned oil and gas well sites. The initiative is part of a larger Lethbridge Research Centre effort to use various organic amendments as tools for rebuilding degraded or disturbed soils.

Composting as value-added. This project was continued to examine how nutrient concentrations in manure change due to composting. The goal is to evaluate the economics of composted manure as a value-added product and develop management strategies. Since fresh manure hauled to the field contains 60 percent or more water weight, composting can significantly lower the cost of long-distance hauling.

Water and air quality

Benchmarks for industry responsibility

Technology, mechanization and crop protection advances have resulted in rapid agricultural change over the past several decades. But, while productivity has improved dramatically, several environmental concerns have emerged. Researchers are addressing water quality concerns and helping Western Canada achieve a harmony between highly efficient agricultural production and environmental protection.

Contamination risks from ranching. A study was initiated at Kamloops to assess the risk of water quality contamination from ranching activities. Factors under evaluation include:

incidence of giardia and cryptosporidium cysts in livestock faeces, access of livestock to water, distribution of livestock densities in relation to the riparian zone, and correlation of high water runoff to livestock distribution and activity. Researchers plan to determine the nature of water contamination with respect to contaminants, timing of contamination, ranch activities and source of contamination. This will inform the livestock industry on the environmental impact of ranching and provide recommendations for reducing the risk of water contamination.

Herbicide sustainability. Researchers continued this long-term study to develop improved herbicide management strategies. The goal is to balance the needs of crop production with environmental and human health concerns. First phase results compared the runoff of herbicides and nutrients into small water bodies under different tillage systems, determined the impact of conservation tillage systems on economics and soil, air and water quality and determined the effects of wind erosion on herbicide transport.

Saskatchewan studies. The Centre continued collaboration with Saskatchewan researchers on several herbicide studies. They looked at nutrient and herbicide inputs in the South Saskatchewan River from the Outlook Irrigation District, developed methods of measuring herbicide vapor fluxes and evaluated methods of reducing vapor losses.

Cutting nitrogen losses in cattle. Scientists developed a new precision approach to protein feeding that can substantially cut nitrogen losses in beef and dairy cattle. The research potential extends beyond the farm base. By increasing cattle nitrogen retention, not only is manure nitrogen lowered for better balanced fertilizer, the potential for volatile urea releases to the atmosphere is also dramatically lowered. The approach has two steps. The first is to maximize rumen microbial protein synthesis. The second is to meet additional protein requirements using a well balanced protein supplement to meet the specific amino acid needs of cattle.

Weight gain fluctuations linked to water source, quality. Results from this ongoing study indicated that where cattle get their water and the quality of that water may have a dramatic impact on weight gain performance. It has long been assumed that as long as cattle have access to an adequate water supply, the only variable that affects their performance is feed, but these results suggest water intake factors are significantly underestimated.

Exploring beef-water-human health links. This study continued to determine if beef cattle are potential sources of giardia and cryptosporidium. Although transmission of these diseases from cattle to humans has not been scientifically proven, cattle have been blamed for outbreaks. Because of the potential of these diseases to infect humans and their potential to negatively impact beef production, scientists hope to uncover the facts about transmission and, if necessary, develop methods for control. The first phase will determine prevalence of the diseases by looking at samples from cow-calf and feedlot operations at strategic locations.

Nutrient runoff, leaching. Scientists compared runoff and leaching of an applied chloride tracer, nitrate and soluble phosphorus under continuous-flow and surge-flow surface irrigation. The data will help determine how nutrients are transported off-site by runoff and leaching and compare the effects of the two irrigation systems on water quality.

Controlling atmospheric emissions from feedlots. A new initiative was started to reduce ammonia emissions from feedlots. By measuring the emissions, determining their impact on crop growth and looking at methods of emission reduction, scientists are working to improve the sustainability of intensive livestock operations.

Herbicide leaching. Researchers evaluated the results of a study which examined the leaching of six herbicides on soils near Lethbridge and Lacombe. All leached more readily in the dark brown soil zone around Lethbridge, which has less soil organic matter than the black soil zone around Lacombe. Factors such as amount and size of soil pores were a major influence on leaching. Also, each herbicide's soil persistence and tendency to adsorb to soil varied between each soil type. Laboratory tests suggest that allowing herbicide residues to adsorb to dried soil before irrigation would significantly reduce herbicide leaching.

Odour control. Scientists continued ongoing efforts to develop strategies for manure application. A major component of the study was monitoring ammonia concentrations downwind from feedlots, periodically throughout the year. Odour management experiments showed that significant control of odour-producing components is possible with relatively simple management practices immediately following manure application.

Nitrous oxide emissions. The potential of crops such as barley and canola to manage nitrous oxide emissions from agricultural lands was examined in this ongoing study. Researchers also determined the effect of chinook winds on the emissions.

Nutrient cycling. Scientists evaluated data from a four-year crop sequence field study which assessed cropping and management strategies, to promote efficient recovery of mineralized nitrogen from decomposing plant residues. Results from this study will help growers minimize nitrogen losses into the environment by promoting efficient internal cycling of nutrients. The study is part of an ongoing project to develop nutrient and residue management strategies under different cropping systems and environments.

Tillage effects on leaching. Data was examined from a major research effort on the physical and hydrological properties of soils under conventional tillage and no-till. A completed two-year study examined unsaturated water flow under conventional tillage, minimum tillage and no-till systems. Another study determined leaching of water and chemicals under conventional tillage and no-till. The effort also examined preferential flow in macropores such as earthworm burrows and root channels under these tillage systems. Macropores are the major pathways for leaching through soil into groundwater.

Range management

Balancing rangeland resources

Protecting Western Canada's rangeland is essential to the future of the ranching industry and important to society as a whole. Researchers in the range management program are developing technology to help maintain that resource as demands on the land increase. Field studies and experiments continue to pursue an optimal balance for rangeland's many uses.

Effects of forage on mining sites. Researchers evaluated the effects of high molybdenum forage, used to help reclaim mining sites, on the health of grazing cows and calves. This ongoing study examines the nature of the organo-molybdate complex in forages grown on mine sites. The structure of the complex may explain the lack of toxicity of the high molybdenum forages to ruminants.

Revise stock poisoning information. The program is expanding and updating a bulletin on "Stock-poisoning Plants of Western Canada," which outlines practical measures for the prevention of poisoning.

Thin Layer Chromatography image analysis. Image analysis methods for Thin Layer Chromatography (TLC) were developed to determine toxic alkaloids in death camas, a type of poisonous plant. This will allow alkaloid analysis at different stages of the plant's growth.

Detoxifying larkspur alkaloids. This study was initiated to develop *in vitro* procedures to assay for the potential for detoxification of larkspur alkaloids by rumen microbes. Tall larkspur in the foothills is a major cause of livestock poisoning; methods to prevent or minimize its damage are needed.

Protecting riparian areas. This ongoing research focused on whether providing cattle with alternative water sources can reduce the need to fence off streams, ponds and creeks to protect those areas. Protection of these riparian areas is increasingly important.

Cattle plant grazing. It is difficult to objectively measure which plants cattle eat when grazing. This study was initiated to develop a measurement method for grazing, based on the variability of plant alkanes, which are waxy hydrocarbons on the plant surface that act like fingerprints.

Impacts of cattle on a grassland community. Researchers began work to determine what effect the removal of large cattle populations has on the soils and vegetation of the mixed prairie ecosystem in Southern Alberta. They compared areas that hadn't been grazed since 1927 with areas currently grazed. It's part of an overall effort to develop a better understanding of the role of cattle in maintaining grasslands.

Tree encroachment on grasslands. Work continued to determine the rate of tree encroachment onto grasslands in the interior of British Columbia. Scientists also examined the relationship between tree encroachment and environmental factors such as slope, aspect and elevation, as well as fire and grazing history. This will help predict the risk of encroachment and provide control strategies.

Soil-plant interaction. This project continued to examine the effects of organic compounds leached from plant roots into the soil. These compounds may trigger a sort of "chemical warfare" that prevents other plants from establishing. The results will help specify the effect of vegetation changes on soil and the long-term implications.

Agriculture effects on native forage production and soil quality. Over 70 percent of the northern great plains are now cultivated for cereals and forages, but there is little known about the effects of that production on the native prairie. This study compared the relationship between different agronomic systems on different soil types in Southern Alberta to generate knowledge for land management strategies.

Insects and ecology. Researchers determined the indirect impact of grasshopper insecticide on grassland bird survival and recruitment. Bird and insect populations were monitored before and after spraying to determine the impact of grasshopper insecticide on food availability and utilization. The data will be used to determine a level of adequate pest control while preventing environmental damage.

Rangeland biocontrol. Researchers pursued new biological controls for grasshoppers that can reduce crop damage inexpensively, without harming the environment. Potential strategies will incorporate biological control agents, such as parasites, predators, microbes and microbe derivatives that specifically attack grasshoppers, to be used with or without insecticides. Researchers also evaluated the potential of using a Chinese strain of the *Altica carduorum* beetle to control Canada thistle.

Grazing. Researchers examined pregnant cows grazing on fescue prairie in winter to determine their response to protein supplementation. The data will be used for optimal winter grazing strategies.

Insect forecasting. Studies determined the influence of body size, orientation, and microclimate on the body temperature of grasshoppers to improve forecasting data. Other ongoing studies will lead to improved forecasting for various insects over large areas.

Winter grazing economics. A study examined the economics of alternative systems such as fall annual pasture, grain supplementation and feedlot conditioning for maintaining cow condition when practicing winter grazing of fescue rangeland.

Soil management

The new sustainable agriculture

Land use planning and management has always had a major influence on agriculture, but science has shown the implications extend far beyond the farm base. Researchers are working to unlock further secrets of how natural processes work within soils. Armed with that knowledge, they can look at a range of land use issues ranging from building better production systems to improving the environment. The goal is to produce land management systems that ensure the sustainability of agricultural and non-agricultural ecosystems.

Carbon cycling. Scientists continued a study of the exchange of soil carbon dioxide, the major greenhouse gas targeted in the Kyoto agreement. Since the pool of carbon within soils is three times that in plants and twice the amount in the atmosphere, agricultural production can have a major impact on the earth's carbon cycle. Scientists are investigating the potential of using agricultural lands as a sink for storing excess carbon dioxide from the atmosphere.

Long-term impact of manure application. Preliminary results of soil studies showed large pores caused by soil cracks, old root channels or earthworm burrows are extremely important in preferential leaching of water and chemicals through the plant root zone, and can have a major impact on groundwater quality. Manure appeared to increase water infiltration at high water potentials or into larger pores, but appeared to inhibit water infiltration at lower water potentials or into smaller pores. Also, higher manure rates generally led to higher soil moisture.

Low input grassy weed control. This experiment examined the effects of VAM fungi on grassy weeds as a potential biocontrol method. It's part of a larger effort to learn about biological activity in agricultural ecosystems so that strategies can be developed to improve soil health and productivity while reducing reliance on external inputs.

Atmospheric fluxes. Several experiments were conducted to measure atmospheric fluxes on agricultural lands. The data will be used to develop methods of reducing carbon and nitrogen losses to the atmosphere to improve soil quality, crop growth and environmental quality. One study compared soil respiration under different management regimes. Other studies examined the impact of tillage on short-term carbon dioxide emission, monitored the rate of ammonia absorption by soils from feedlot manure, determined the impact of ultraviolet rays on the decomposition of wheat straw, determined the effects of tillage and nitrogen fertility on the breakdown of cereal residues under irrigation, and developed a forecasting model to predict soil respiration.

Sustainable weed control. Researchers continued to pursue weed control measures for prairie cropping systems that maintain crop yield, reduce input costs and minimize environmental impact. A series of field experiments were conducted to evaluate experimental herbicides and herbicide application methods as well as explore sustainable weed control methods for reduced tillage systems. Control methods studied included cultural practices such as plant residue management, optimum timing and placement of fertilizer and manure to manage weeds and increase yields, use of cover

crops, and various integrated management systems. The performance of a weed-sensing sprayer was also evaluated in conservation fallow and cropping systems.

Soil restoration. A long-term study determining the changes in crop yield and soil quality during six years of artificial erosion was completed. The results will contribute to efforts to develop methods of restoring the biological, physical and chemical properties of soils damaged by erosion, disturbance, or degradative management practices.

Precision farming. Scientists continued to explore the potential of new satellite technology that could lead to improvements in sustainable production. Researchers evaluated the potential of related technology to monitor agricultural practices from satellites, developed a baseline map of soil conservation practices on the Prairies, began evaluation of the potential of remote sensing for range management, and set up a field program to identify the role of remote sensing for precision farming systems in Southern Alberta. Precision mapping will allow farmers to target the specific inputs they need for each small area of land. The technology will also enable researchers to assess the adoption of conservation measures and develop strategies for sustainable soil management.

Remote sensing space project. The Centre contributed remote sensing expertise to a major United States-based agricultural venture. Plans for the ongoing initiative are to launch four satellites in 2001, equipped with remote sensing capability to take constant "snapshots" of the earth's surface and to use this information to build products that provide information on soils, crop vigor and plant stand.

Long-term plots. Since changes in land due to management practices occur over decades, the Centre has an invaluable resource in its long-term crop research plots, some of which date back to 1910. Researchers continued monitoring the plots to determine the eventual impact of current and experimental cropping practices on soils and adjacent environments. In addition to continuing dryland, irrigation, tillage, carbon cycling and other long-term experiments, scientists established a baseline for a new long-term low-input rotation, and began the development of an economic computer model to predict the effect of climate change on cropping practices and carbon release.

Worm Watch biodiversity program. Worm Watch - a program to collect data on the biodiversity of earthworms across Canada - was further developed. The program sparked national attention for its dramatic potential as a tool for science education and for the development of indicators for soil health and quality. Worm Watch has been recognized as a "Canadian contribution to the UNESCO program, Man and the Biosphere," by the program's Canadian branch. It is also one of Canada's contributions to the program on agricultural biodiversity under the International Convention on Biological Diversity.

Earthworms as soil managers. Research showed high wheat yield, and some lessening of clubbing and stunting when earthworms are included in take-all inoculated treatments. Previous studies showed earthworms are effective residue and disease managers under no-till. Results indicated earthworms generally favor zero-tillage environments, and contribute to a significant decrease in surface residues.

Native plant potential for land reclamation and production. Public demand to use native plant material means agriculture needs information on species productivity and performance in mixes. Studies continued to evaluate the impact of heterogeneity among native and introduced stands on forage production and soil quality. Several plants show promise for reclamation, wildlife habitat, forage and improved soil quality.

Sustainable agriculture. Continued research was completed into this important approach to farming. Sustainable agriculture takes elements of both conventional and organic management methods. It focuses on fine-tuning cropping systems to reduce off-farm inputs. Several field studies and experiments are ongoing.

Sustainability project in Lowland China. Scientists continued to collaborate with Chinese researchers on the Hebei Dryland Project, a program sponsored by the Canadian International Development Agency (CIDA) to improve farming practices in the nation's Hebei Lowland region. The program continued a five-year phase focusing on sustainable farming practices. Lethbridge researchers used their background in sustainability and dryland farming to help train Chinese researchers and advise them on individual research areas. A previous five-year phase focused on improving crop yields.

Monitoring Alberta soil change. A study was continued to monitor changes in soil quality at benchmark sites across Alberta. The results will help assess agricultural sustainability in the province and contribute to land management strategies.

Soil database. A four-year project to build a standardized digital database describing agricultural soil landscapes in Alberta was completed. The Agricultural Region of Alberta Soil Inventory Database (AGRASID) was published on compact disc. It can be used with GIS to generate maps for land-use planning and to plan farming systems.

Balancing crop production, soil conservation. Research looked at effects of tillage and crop rotation on crop yield and quality, and on the soil's physical and chemical properties. Preliminary results indicate that crop yields and soil properties under conservation tillage are similar to those under conventional tillage.

Input strategies to battle erosion. Results showed that inorganic fertilizers are not cost-efficient tools for improving soils with high levels of erosion, even at high grain prices and low fertilizer costs. Using organic matter to improve soils looks more promising, but depends on soil properties, fertilizer use and climatic conditions. Ongoing study targets economic strategies.

Potatoes

Industry-driven progress

Researchers continue an innovative approach to developing disease resistant, high quality potato cultivars and germplasm for Western Canada. The program has a heavy industry-driven, high-tech flavor, and is backed by research into sustainable disease and insect control strategies.

Partnership with Texas A&M yields new potato cultivar. Original potato crosses were made in Texas, and the selections were done in Lethbridge. The result was a potato cultivar that, under irrigation, out-yielded Russet Burbank by 10-100 percent in advanced yield trials. AC Stampede Russet has excellent french fry quality, skin set, tuber size and shape uniformity. It is also resistant to verticillium wilt and fusarium dry rot. Suitable for the french fry and fresh markets, this potato gives the industry a dual-purpose alternative to Russet Burbank, with earlier maturity, superior yield, lower defect levels and superior fresh market appeal.

Consortia boost variety development. The program continued its industry-driven initiative with the Western Canadian Potato Breeding Consortium. The original three-year Consortium pilot project which produced 14 variety clones adopted by industry is in the second year of a renewed five year project. It is based on an agreement between multiple industry partners and the Centre, whereby the partners evaluate, promote and market products produced by the potato program in exchange for first right of refusal to those varieties. That project, which focuses on classical breeding, is now known as Consortium "A." A new second project, Consortium "B," was added as a five-year project to focus on breeding using biotechnology. The overall objective of the Consortia is to improve the introduction of varieties for the Western Canadian potato industry. Ongoing studies target improved varieties for the french fry and chipping markets.

Colorado potato beetle control. Researchers continued developing an insecticide resistance management program for the Colorado potato beetle, the most destructive insect pest of potatoes worldwide. The goal is to help Western Canada avoid the buildup of resistance to commonly used chemical control products that has occurred elsewhere in the world and to develop alternative controls. For the first phase of the project, scientists are studying the phenology (life cycle, movement within the crop, overwintering habits, etc.) of the beetle in Western Canada. As an alternative control strategy, they are also studying the effectiveness of a fungus that is a naturally occurring pathogen of the potato beetle with the potential to decimate beetle populations.

Agronomy packages. Phase one of an initiative to provide management packages for advanced breeding material was completed. Researchers conducted spacing, nitrogen fertilization and bruise susceptibility studies to develop potato clones with commercial potential.

Blackleg project draws on wild genetics. Scientists continued to search wild potato species for resistance to the blackleg bacteria. This is the first phase of a new study to combat the bacteria, which causes approximately $32 million in damage to potato crops in Alberta each year. The goal of the project is to identify new sources of genetic resistance and incorporate them into new potato varieties. Since domestic varieties come from very few introductions, wild potatoes offer a wider pool of genetic diversity. Most of the wild species selected for screening are from the United States Department of Agriculture in Wisconsin, which has the largest collection in North America.

Disease technology. Other disease efforts targeted fusarium dry rot, early blight, leaf roll and common scab, using traditional and biotechnology methods. A major effort has been developing allele-specific DNA markers for a verticillium wilt resistance gene from tomatoes. One completed study determined disease reactions among advanced Lethbridge breeding lines.

Wheat

Reinventing Western Canada's specialty wheats

As a western link in the vast Agriculture and Agri-Food Canada crop development network, the Lethbridge Research Centre targets two specialty wheats. The first is soft white spring wheat, a niche crop for irrigated areas in Southern Alberta that has diverse market benefits. The second specialty market is winter wheat, a crop with exciting potential for wider adaptation.

New winter wheat for Southern Alberta. A new high-quality winter wheat was developed and is expected to become the standard in the traditional growing areas of Southern Alberta. AC Tempest out-yielded AC Readymade, the current standard, by an average of 4 percent over three years of testing. AC Tempest is very strong-strawed and high in protein, with improved grain yield compared to AC Readymade. It is also moderately resistant to bunt.

Pioneering "gene stacking" work. Scientists continued pioneering work in gene stacking or pyramiding - a new approach to building disease resistance into crop cultivars that could lead to a new era of indomitable and long-lasting disease resistance. Many common crop pathogens, such as rust and bunt in wheat, mutate over time and eventually overcome individual sources of resistance. Gene stacking, or incorporating multiple sources of resistance into one variety, dramatically decreases the chances of that happening. Researchers developed new molecular markers for two wheat genes with resistance to bunt, making a stacked resistance approach possible.

Tapping winter wheat potential. It could be the perfect crop: very high yields, protein and quality along with early maturity and agronomic requirements well suited for the shift toward reduced tillage and sustainable rotations. But winter wheat requires careful management and specific adaptations. Researchers continued working toward new varieties and strategies to meet those criteria. Ongoing studies concentrate on disease and agronomic advances to move winter wheat production into the central and northern prairies. Snow mold resistance and cold-hardiness are two current targets. Scientists identified material with both characteristics for use in the breeding program. Other studies selected for better resistance to common bunt.

Breeding technology. Several new breeding methods were evaluated for efficiency, cost-effectiveness and suitability in the wheat development program. One study determined the relative efficiency of anther culture and wide hybridization (wheat x corn) techniques in producing haploids of common wheat. Also, a marker linked to common root rot susceptibility was discovered. A new study was initiated to determine the influence of genotype and environment, and their interaction on the end-use quality of SWSW. The data will help develop cultivars that consistently produce high quality grain. Ongoing studies aim to: identify DNA markers for stripe rust resistance genes; evaluate the potential of microsatellite sequences for developing DNA "fingerprints"; determine the chromosomal location of genetics controlling disease resistance in the wheat-alien hybrid line Agrotana; develop markers for bunt resistance to facilitate pyramiding of such genes; develop markers for snow mold resistance and freezing tolerance in winter wheat; and identify markers for potential chromosome substitution lines of hard red spring wheat cultivars.

Diseases. Researchers used image analysis procedures to determine the influence of common root rot on the growth and discoloration of the root system of resistant and susceptible barley. They also developed an image analysis protocol for rapid accurate measurement of black point resistance, and determined the chromosomal location of stripe rust genes. Other ongoing activity aims to determine the influence of nitrogen fertilizer rates and seed treatments on disease severity in SWSW, and select for bunt resistant cultivars of SWSW and winter wheat.

Agronomy. New studies were started to determine the relationship between sugar composition or concentration and level of freezing tolerance or snow mold resistance. These studies also aim to determine the optimum date of seeding for cold-hardy, snow mold resistant winter wheat in central and Northern Alberta.

Field crops

A new diversity initiative

With common bean production expanding in both area and cash value in Western Canada, the Lethbridge Research Centre has targeted its field crop program at tapping the potential of this emerging crop alternative.

Breeding technology. Ongoing efforts aimed at developing improved upright dry bean lines adapted to the short growing season of Western Canada. A new study will assess the relative time to maturity of bean germplasm from the Middle America and Andean South America gene pools. The objective is to determine whether this germplasm can contribute to early-maturing beans for prairie producers.

Diseases. Researchers determined the effect of various densities of stork's bill and the various lengths of its interference on the yield of dry beans, field peas, canola, and soft white wheat. This will help growers predict when control measures are needed. Also, new studies initiated in 1997 will select bean cultivars that show improved resistance to white mold and grey mold for use in the breeding program. One study will determine the yield and quality of potential upright lines of dry beans grown in commercial fields, under natural stress of white mold.

Weeds. Researchers evaluated an experimental herbicide to test its potential for providing improved post-emergence selective control of grass and broadleaf weeds in dry beans, field peas and lentils. The herbicide showed potential and will be submitted for registration. Scientists continue to develop an improved weed management system for dry beans through cultural methods. They will also evaluate an improved weed management system for field peas. Another study will determine the correlation between weed growth rates and the dose of herbicide required for control. Finally, researchers aim to develop a weed management computer module for forecasting.

Biocontrol

Integrated strategies for sustainable control

The Centre has a cross-Canada mandate for research in weed biocontrol using insects and also explores other forms of this sustainable control alternative. A key focus is the protection of forages from rangeland weeds, research that is part of the Lethbridge Research Centre's national mandate for beef production systems. Weeds in cultivated fields are another major target.

Pathogens for disease control. Researchers screened many pathogens for their impact on the blossom blight disease of alfalfa and the damping off disease found in pulse, oilseed and sugarbeet crops. The most effective pathogens were selected and will be investigated to determine their potential for controlling these diseases.

Improving biocontrol with soil amendments. Work continued on the effect of different crop residues and formulated compounds (composted manure and other agricultural wastes) on the survival of soilborne pathogens and beneficial organisms.

Battling leafy spurge. The Centre and Southern Alberta's Blood Tribe continued their joint effort to control leafy spurge, a noxious weed that has spread to about 8000 acres on the Tribe's reserve. The plan is to use insects that feed on the weed as biocontrol agents in addition to control efforts by the Tribe using sheep and chemicals. Agents include the black-dotted beetle, the brown-dotted beetle and two flat-back beetle species. The long-term project will help the Tribe reduce leafy spurge to tolerable levels and provide valuable information for the weed biocontrol program.

Restoring native species. Scientists continued to investigate the use of biocontrol as a management tool for restoring native species to rangeland. Many introduced weeds compete better than native plants and have taken over portions of the land base, but biocontrol gives researchers a tool to help reclaim that territory. Ongoing studies target foreign weeds such as knapweed and spurge.

Targeting noxious weed hound's tongue. Controlling hound's tongue using a European weevil remained the focus of this biocontrol study. This plant, a noxious weed that infests over 2000 hectares in the province's southern region, has become a serious problem for cattle producers. The weed hinders forage establishment, its burrs irritate cattle and can reduce their market value, and its high toxicity can cause poisoning. In Europe, where the weed originates, the weevil larvae feed on hound's tongue roots and show good potential for the North American problem.

Pathogens target pests. Research continued to explore the use of pathogens for biocontrol of pest insects of rangeland, cereal crops and potatoes. That control option is becoming increasingly important for environmentally sustainable agriculture.

Integrating biocontrol into grasshopper strategy. Scientists worked toward new biological controls for grasshoppers as a way to reduce crop damage inexpensively without harming the environment. A suite of natural controls - including parasites, predators, microbes and microbe derivatives - shows great promise as a component of integrated grasshopper management strategies.

Lethbridge Research Centre Staff

The Lethbridge Research Centre welcomes questions, comments or suggestions at anytime. All staff are available through the main Centre lines: phone (403) 327-4561, fax (403) 382-3156, Web site, http://res.agr.ca/leth. General inquiries are also received through the main Centre email: lethbridge@em.agr.ca.

Management
Steve Morgan Jones, Director
Peter Burnett, Assistant Director
Glenn Coulter, Assistant Director

Livestock Sciences
Bob Kemp, Acting Section Head, Genetics
Doug Colwell, Assistant Section Head, Livestock Parasitology
Lyle Rode, Assistant Section Head, Ruminant Nutrition
John Baah, Feed Biotechnology and Nutrition
Danica Baines, Livestock Insect Cell Physiology
Karen Beauchemin, Ruminant Nutrition
Bernhard Benkel, Molecular Genetics
Sylvie Bilodeau-Goeseels, Molecular Biology
Nicolas Caron, Genetics
Cathy Gallivan, Genetics
Patrick Charagu, Genetics
Denny Crews Jr., Genetics
Kevin Floate, Insect Biocontrol
Bob Forster, Rumen Biotechnology
Brian Freeze, Bioeconomist
Washington Gwayumba, Ruminant Nutrition
Alex Hristov, Nutrition/Microbiology
Mike Ivan, Nutritional Physiology
Sushil Jacob John, Molecular Biology
John Kastelic, Reproductive Physiology
Karen Koenig, Ruminant Nutrition
Eric Kokko, Electron Microscopy and Image Analysis
Fran Leggett, Electron Microscopy and Image Analysis
Tim Lysyk, Livestock Insect Population Ecology
Tim McAllister, Feed Biotechnology/Nutrition
Gerry Mears, Livestock Physiology
Priya Mir, Digestive Physiology
Zahir Mir, Ruminant Nutrition
Diego Morgavi, Ruminant Nutrition
Pius Mwansa, Genetics
Victor Nsereko, Nutritional Biochemistry
Ron Teather, Molecular Biology
Yuxi Wang, Ruminant Nutrition/Microbiology
Marc Whitford, Molecular Biology
Jay Yanke, Bacteriology
Wen Zhu Yang, Ruminant Nutrition
Shahiduz Zaman, Ruminant Nutrition

Land Resource Sciences
Walter Willms, Acting Section Head, Range Ecology
Frank Lamey, Assistant Section Head, Soil Conservation
Wole Akinremi, Agroecosystem Modelling
Chi Chang, CIDA Project Coordinator
Jill Clapperton, Rhizosphere Ecology
Gerry Coen, Pedology
John Dormaar, Organic Chemistry (Emeritus)
Ben Ellert, Carbon Cycling
Toby Entz, Statistics
Xiying Hao, Soil Physics
Henry Janzen, Soil Biochemistry
Dan Johnson, Rangeland Insect Ecology
Sean McGinn, Agrometeorology
Jim Miller, Soil & Water Specialist
Anne Smith, Remote Sensing
Elwin Smith, Bioeconomics
Joann Whalen, Soil Chemistry
John Wilmshurst, Range Ecology

Kamloops Range Research site
Doug Veira, Site Manager, Animal Behavior
Yuguang Bai, Tree Encroachment
Klaas Broersma, Soil Science
Walter Majak, Range Plant Biochemistry
Don Thompson, Range Plant Physiology

Crop Sciences
Rick Butts, Section Head
Bob Blackshaw, Assistant Section Head, Cereal and Special Crop Weeds
Surya Acharya, Forage Breeding
Sylvie Bardin, Field Crop Diseases
Rob Bourchier, Insect Ecology/Weed Biocontrol
Bob Byers, Honorary Research Associate
Héctor Carcámo, Insect Pest Management
Qin Chen, Molecular Cytogenetics
Bob Conner, Cereal Diseases
Rosemarie De Clerck-Floate, Weed Biocontrol
Francois Eudes, In Vitro Culture
Debbie Fujimoto, Molecular Bacteriologist
Dennis Gaudet, Cereal Diseases
Mark Goettel, Insect Pathology
Rob Graf, Winter Wheat Breeding
Peter Harris, Weed Biocontrol (Emeritus)
Bernie Hill, Environmental Chemistry
Henry Huang, Forage Crop Diseases
Larry Kawchuk, Molecular Pathologist
André Laroche, Wheat Molecular Genetics
John Lu, DNA Fingerprinting
Dermot Lynch, Potato Breeding
Jim Moyer, Forage Weeds
Hans-Henning Mündel, Bean Breeding
Christine Noronha, Entomology
Cory Nykiforuk, Molecular Biologist
Brian Orshinsky, Forage Cytogenetics
Sadash Sadasivaiah, Soft White Spring Wheat Breeding

Administration
Marc Parent, Head, Administration
Tracy Lund, Systems Manager
Steve Mihok, Technology Transfer Officer
Cheryl Ronning-Mains, Librarian
Sheila Torgunrud, Graphics

Senior supervisors
Brian Beres, Head of Agronomy Unit, Crops
Brian Farries, Field Operations, Land
Tom Kveder, Head of Greenhouse, Phytotron & Grounds, Crops
Larry Maio, Operations, Kamloops
Allan Ross, Ranch Manager, Onefour, Livestock
Terry Seely, Vivarium, Livestock
Graham Steacy, Farm Manager, Lethbridge, Livestock

Lethbridge Research Centre

Affiliated research sites

Kamloops Range Research Site. Linked with the Centre in 1993. British Columbia's major site for agro-forest research is directly linked to the Centre's range management program.

Onefour Ranch. A 17,000 ha (42,000 ac.) short grass prairie range research site near Manyberries, Alta. The Centre's main site for cattle genetics and breeding research. It is home to a 450 cow Angus herd and a 250 cow Charolais herd. Both are owned by the Canada/Alberta Livestock Research Trust Inc. – a unique partnership between the Lethbridge Research Centre and Alberta beef, sheep and dairy producers. It's a non-profit, livestock industry driven research trust, with all revenues from sale of the livestock and their by-products reinvested in the Lethbridge research program.

Stavely site. A 390 ha (960 ac.) site for rough fescue range research.

Vauxhall site. A 190 ha (480 ac.) site for potato, soft white wheat and rotation research.

Acknowledgment: Communications sponsored in part by The Canada/Alberta Livestock Research Trust Inc.

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

The Lethbridge Research Centre, Gaol Road, Lethbridge. Mail: P.O. Box 3000, Lethbridge, Alberta, Canada, T1J 4B1
Phone: (403) 327-4561 Fax: (403) 382-3156 Website: http://res.agr.ca/leth.